National Aeronautics and Space Administration

Teaching Note for NASA Case Study GSFC-1007T-1

Launching the *Vasa*

Any number of parallels can be made with the *Vasa* story to modern engineering projects. Some such parallels are listed here and can be elaborated upon depending on the instructor's familiarity and the students' particular interests:

1. Choose a "biggest-ever"-type project, such as *Titanic*, *Challenger*, *Columbia*, and discuss how it failed.
2. Irrational requirements on the part of stakeholders: The king wanted the *Vasa* to be better than the Danish ship, but would it actually help him win the war?
3. Being asked to build something that is clearly beyond contemporary engineering knowledge and capabilities. Some of the knowledge gaps:
    a. Center of gravity;
    b. Measuring ballast;
    c. Ship-handling characteristics under different structural designs;
    d. Changing methods of naval warfare requiring more and bigger guns;
    e. Lack of written designs, design trades, and systems integration;
    f. Compromises made without knowledge of consequences;
        i. Lengthening of keel (twice),
        ii. Adding beam, ballast, height, and weight (guns and decorations).

4. Conflict between 'customer' and designer:
    a. Lack of any independent safety or assurance program;
    b. Absence of any checks and balances on decision-making process.
5. Inadequacy of testing:
    a. Lurch test simplest of simple tests;
    b. Lack of sharing of test results (admiral did not consult shipbuilder on lurch test);
        i. Can lead to: "Yes, the test was done;"
        ii. Test results become almost irrelevant (example: Genesis case);
            1. Did you test what you thought you tested?
            2. What result did you get? Did it make sense? Who checked?
6. Balancing career survival versus responsible oversight:
    a. The problem was evident (most seamen who boarded remarked on the instability of the ship);
    b. People assumed it was not their responsibility to do anything.

This case can be used to spark discussion about the role of testing in areas of an unknown experience base to emphasize the value and importance of tests where there is no data. The WIRE (Wide-Field Infrared Explorer) mission, in which bench-test anomalies were discounted by rebooting the power supply, comes to mind (the spacecraft was lost when an electrical short-circuit occurred shortly after launching). The DART (Demonstration of Autonomous Rendezvous Technology) satellite had some similar issues. The concept of *weak* signals could also be emphasized with reference to *Challenger* or *Columbia* or other well-known NASA mishaps.

The participants should be able to understand that though this looks silly to lose life and ship when it seemed everyone could sense something wasn't right, it never looks that way to the individuals involved until after the fact. "Trust the shipbuilders. They've built many ships before that worked." That is, in fact, the phenomenon of talking yourself into success despite all the evidence (signals staring you in the face).

The focus on risks is intended to open the discussion to how fuzzy risks are documented, and how attention needs to be addressed to solving them with the same rigor as specific technical or safety risks. The four risk examples (fictionalized to the *Vasa*) are adapted from four actual top-level risks in NASA's Exploration Systems Mission Directorate (ESMD) around fall 2007. In other words, we have these same types of risks in NASA today. Hopefully, with much better communication tools, engineering analysis, and independent reporting structures, these types of risks won't lead to outcomes like the *Vasa*.

The risks can be discussed by asking the participants whether they think NASA has any risks similar to the ones the *Vasa* case identified. It can be revealed then that these, in fact, are real NASA risks being worked today within ESMD. This could lead to a large or small group discussion of how the participants can work toward mitigating those types of risks on their own projects.

Note

There is a Harvard business case version of the *Vasa* story with a bit more detail on the ongoing war, changes in naval warfare, and some details from the inquiry that was held after the disaster. Facts and insights from that case may be used by the instructor to answer some questions or satisfy curiosity though the final answer of the inquiry was, 'no explanation.' The Web site for the museum has further details on the raising of the ship, specifications deduced by archeological investigation, and further interesting details about the saga.

Vasa Museum Web site: http://www.vasamuseet.se